PULNiX

TM-6760

AccuPiXEL® Series

High Performance ~
~ Modular Design

CAMERA Link® versions available

The TM-6760 is a miniature, VGA monochrome progressive scan CCD camera. Based on a high-quality Kodak 1/2" progressive scan image sensor, this camera's most outstanding feature is its ability to capture 60 frames per second at full resolution, offering an excellent price/performance ratio. Applications for the TM-6760 include machine vision, medical imaging, intelligent transportation systems, robotics, gauging, character recognition, and surveillance.

- High-speed 1/2" progressive scan 648(H) x 484(V) interline transfer CCD imager
- Color version (RGB Bayer CFA) is available as TMC-6760 - (see Color AccuPiXEL data sheet)
- **Camera Link** versions order TM-6760CL and TMC-6760CL - (see Camera Link data sheet)
- Miniature 44x44x64 mm housing with high-rel connector
- Digital RS-644 (LVDS) output and analog output
- 60/30 frames per second selectable
- Full frame integration, Two-row binning (648x242 pixels) at 120 fps, Partial scan (200 lines, 120 fps)
- Full-frame shutter to 1/32,000 sec.
- Asynchronous reset, no-delay shutter
- Maximum dynamic range control with PULNiX-exclusive, patent-pending built-in look-up table
- Read-out-inhibit control for multiple-camera applications
- RS-232 external control

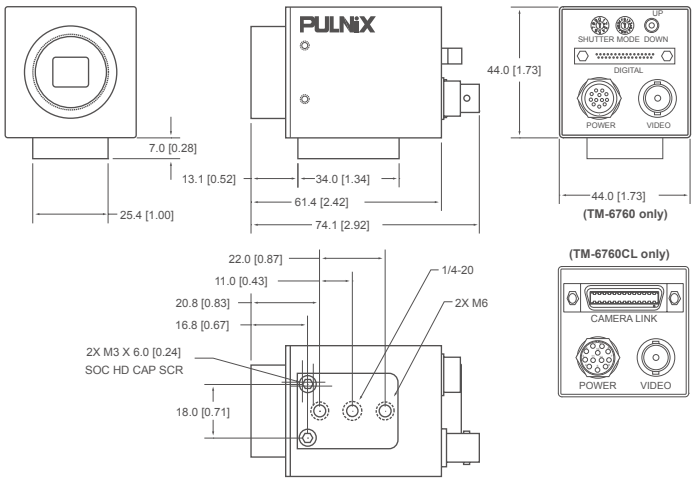
AccuPiXEL®

AccuPiXEL® is a registered trademark of JAI PULNiX, Inc.

TM-6760 Specifications

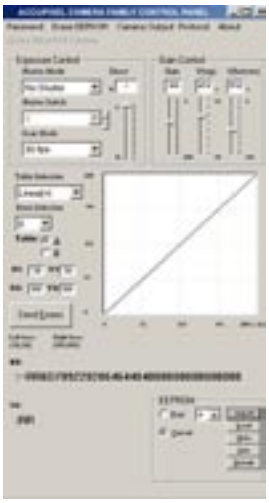
Imager	*1/2" progressive scan interline transfer CCD*
Active Area	*5.83 mm x 4.36 mm*
Active Pixel	*648 (H) x 484 (V)*
Cell Size	*9.0 µm x 9.0 µm*
Display Modes (Active Pixels)	*648 (H) x 484 (V) @ 60/30 Hz (VGA output)* *648 (H) x 200 (V) @ 120 Hz (partial scan)* *648 (H) x 242 (V) @ 120 Hz (two -row binning)*
Sync	*Internal/external auto switch* *HD/VD, 4.0 Vp-p impedance 4.7K Ω* *VD=60/30 Hz± 2%, non-interlace* *HD=31.48/15.74 kHz ± 2%*
Data Clock Output	*25.00/12.5 MHz*
Resolution	*Digital: 648 (H) x 484 (V)* *Analog: over 500 TV lines (H) x 484 TV lines (V)*
S/N Ratio	*48 dB min. (AGC off)*
Min. Illumination	*1.0 lux, f=1.4 without IR cut filter (no shutter)* *Sensitivity: 11.5 µV/e-*
Video Outout TM-6760	*Analog: 714mV, 75Ω (900 mV white clip)* *Digital output: 8-bit RS-644*
TM-6760CL	*Camera Link: (see Camera Link data sheet)*
AGC	*OFF*
Gamma	*Programmable LUT (1.0 std)*
Lens Mount	*C-mount (use >1/2" format lenses)*
Power Req.	*12V DC ± 10%, 380 mA (current measured at 25°)*
Operating Temp.	*-10°C to 45°C*
Vibration	*7 Grms (10 Hz to 2000 Hz) Random*
Shock	*70G*
Size (W x H x L)	*44 mm x 44 mm x 64 mm* *(1.73" x 1.73" x 2.51")*
Weight	*133 grams, 4.7 oz (without tripod)*

MUST BE ORDERED SEPARATELY	
Opt. Functions	*Adjustable back-focus front end,* *pixel clock locking*
Opt. Accessories	
I/O CL	*26CL-02-26*
RS-644	*30DG-02 digital output cable*
	CS-232E serial communications kit
Power Cable	*12P-02S*
Power Supply	*PD-12UUP series (includes power connector)*



Graphical User Interface

A user-friendly graphical user interface (GUI) is provided in the CS-232E kit. This interface allows users to control the following functions of the TM-6760 camera:



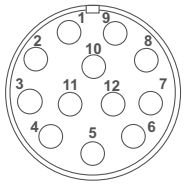
- Shutter control for manual async. and pulse width control
- Gain control
- A/D reference voltages control for Vtop and Vbottom
- Save settings
- Load settings
- Report settings
- LUT setting and graphic display
- Scanning mode selection and Option selections

	Mode Switch	Up/Down Switch	Functions
0	Switch Disabled	Switch Disabled	None
1	Set Gain	Up / Down	Change gain
2	Set Vtop (A/D)	Up / Down	Change A/D ref. top
3	Set Vbottom (A/D)	Up / Down	Change A/D ref bottom
4	Gain Selection #1	Up: 9dB, Down: 12dB	Lower gain selection
5	Gain Selection #2	Up: 18dB, Down: 22dB	Higher gain selection
6	Linear LUT	Up	Back to linear table
7	Knee Selection	Up / Down (Scroll)	Scroll 8 different LUTs
8	Async Reset Mode	Up: Normal, Dwn: Async	Async and normal shutter
9	Factory Default Recall	Up / Down: Recall	Factory setting
A	Power up Setting	Up: Recall, Dwn: Save	Power up page setting
B	User Page Storage#1	Up: Recall, Dwn: Save	User page storage setting
C	User Page Storage#2	Up: Recall, Dwn: Save	User page storage setting
D	Direct Shutter Control	Up / Down	Increment by 1H
E	Scan Format2	Up: PS200L, Dwn: Binning	Scan mode
F	Scan Format1	Up: 60 fps, Dwn: 30 fps	Scan mode

12-Pin Connector

1	GND (power)	7	VD in
2	+12V	8	GND
3	GND (analog)	9	HD in
4	Video out	10	RXD(RS232)*
5	GND (digital)	11	INTEG/ROI*
6	VINIT in*	12	TXD(RS232)*

* TM-6760 only; for CL models the Camera Link connector should be used



Shutter Speed

	Manual	Async
0	no shutter (1/60)	no shutter (1/60)
1	1/125	1/32,000
2	1/250	1/16,000
3	1/500	1/8,000
4	1/1,000	1/4,000
5	1/2,000	1/2,000
6	1/4,000	1/1,000
7	1/8,000	1/500
8	1/16,000	1/250
9	1/32,000	Ext. pulse width control

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71-0079 Rev B.05.25.2004

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PULNiX
Camera Link™ Cameras

Camera Link is a new digital transmission method, designed by vision product manufacturers specifically for the machine vision industry, in answer to customer requests. It is an easy way to connect digital cameras to frame grabbers.

Camera Link is a camera-to-frame grabber interface specification based on an implementation of Channel Link™ technology. It includes hardware (cable connectors), & data transmission as well as camera control and asynchronous serial communications all on a single cable. Now, only two connections (power and Camera Link) are required to operate the camera.

The specification was developed through an initiative headed by PULNiX America, Inc. Camera Link defines a single connector for both the frame grabber and the camera. This insures that all products bearing the Camera Link logo are interchangeable with each other. The official Camera Link logo is shown to the right.

As a standard that has been defined by industry members, Camera Link provides the following benefits:

- **Real-time signaling:** Camera Link supports real-time signaling. Camera Link cameras accept signals including asynchronous reset (Vinit), HD, VD, and integration through the Camera Link cable, without latency (delay).
- **High data rates:** A base configuration Camera Link interface can handle 1.2Gbps of data. The technology used in Camera Link has a maximum data rate of 3.5Gbps, insuring solutions for tomorrow's applications.
- **Flexibility:** Camera Link is independent of imager resolution, video format, and frame rate. In contrast, some other digital transmission standards are set for specific pre-defined video formats.
- **Platform independence:** Camera Link is a hardware specification designed by camera and frame grabber manufacturers specifically for the Machine Vision industry. The frame grabber software must be Windows™ 9X/2000 compatible, but is independent of support from third parties like Microsoft, Apple, or Intel.

Camera Link℠ is a registered copymark of the AIA

- **Simple interface:** Only two connections are required to interface a camera and frame grabber: Power and Camera Link. Cameras and frame grabbers can be easily interchanged using the same cable.
- **Standardized cable assembly:** Camera Link specifies a standard cable assembly. This eliminates the need for manufacturers to provide custom cables, and allows customers to take advantage of lower cable prices. In addition, the technology used in Camera Link reduces the number of wires required to transmit data, allowing for thinner cables, which are more robust and less prone to breakage. Various cable lengths are available up to 10m.
- **Extensive application software support from frame grabber and vision software companies:** Machine vision applications require robust and field-proven software. Camera Link is a quick and simple way for users to standardize their systems for existing applications without having to verify new software.
- **Long-term, stable supply:** Channel Link technology is committed to providing long-term support to the telecommunications industry. Unlike most consumer products, the basic architecture will remain stable for many years to come.

Channel Link™ is a registered trademark of National Semiconductor.

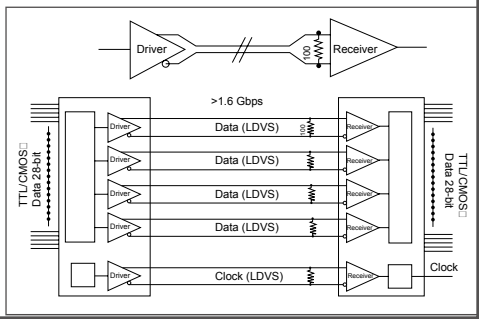
Windows 2000™ is a registered trademark of Microsoft Corporation.

Channel Link Technology

The heart of Camera Link is Channel Link, a data transmission method by National Semiconductor. Channel Link is made up of a receiver chip and a transmitter chip. This chipset is used to transmit digital data. This technology offers many advantages to machine-vision applications over the previous method, namely, RS-644 (LVDS format of RS-422).

LVDS (Low Voltage Differential Signaling) has become the most common means to transmit digital data in recent years. This method, however, has several major drawbacks. LVDS requires a pair of wires for transmission of each data bit, creating bulky cables prone to breakage if stressed. Also, the maximum data transmission rate of LVDS is 400 Mbps, fast enough for today's applications, but limiting for tomorrow's requirements. Channel Link takes LVDS to the next level.

Channel Link uses LVDS standards to transmit data. Far fewer wires, however, are needed to transmit the data. A Channel Link transmitter will convert 28 bits of data into a format that can be transmitted over 4 parallel lines. A transmit clock over a fifth line finishes the requirements for Channel Link transmission. The diagram to the right shows how just five pairs of wire are able to transmit data that would require 56 wires using standard LVDS methods.



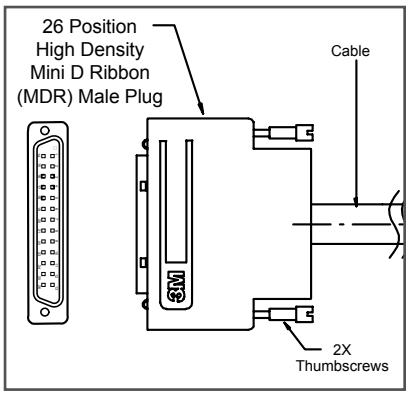
Camera Link Connector and Cable Configurations

A single Camera Link connection provides the following information on an MDR connector with 26 pins.

Image data and timing	4 pairs
	1 pair transmission clock
Serial communication	1 pair transmit
	1 pair receive
Camera Control	4 signal pairs

This configuration will transfer up to 28 bits of data. For applications that require more bandwidth, additional Camera Link connections can be used.

There are 3 configurations – base, medium and full. Please visit the PULNiX web site for detailed specifications of Camera Link.



Camera Link Cable

Note: *The MDR-26 cable assembly is manufactured by 3M Corporation.*

Camera Link Cable Ordering Information

Camera Link cables are available from multiple vendors.

JAI PULNiX P/N	3M	Intercon I	Length
Molded Cables			
	14T26-SZLB-100-0LC	CLCP-1.0-p	
26CL-02-26	14T26-SZLB-200-0LC	CLCP-2.0-p	
	14T26-SZLB-300-0LC	CLCP-3.0-p	
	14T26-SZLB-500-0LC	CLCP-5.0-p	
	14T26-SZLB-700-0LC	CLCP-7.0-p	
	14T26-SZLB-A00-0LC	CLCP-10-p	
	14T26-SZLB-450-0LC	CLCP-4.5-p	
Shell Kit Cables			
	14B26-SZLB-100-0LC	CLCPH-1.0-p	
	14B26-SZLB-200-0LC	CLCPH-2.0-p	
	14B26-SZLB-300-0LC	CLCPH-3.0-p	
	14B26-SZLB-450-0LC	CLCPH-4.5-p	
	14B26-SZLB-500-0LC	CLCPH-5.0-p	
	14B26-SZLB-700-0LC	CLCPH-7.0-p	
	14B26-SZLB-A00-0LC	CLCPH-10-p	

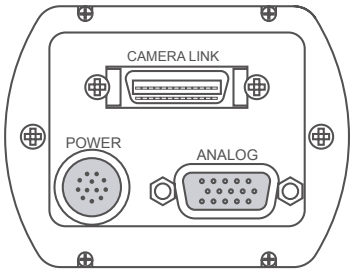
Connector and Pin Configurations

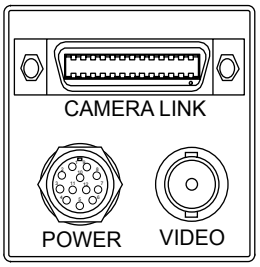
Camera Link Connector (MDR 26-pin connector)

Rear Panel top view

Rear Panel

TMC-6700CL/TMC-1000CL AccuPiXEL™ Series

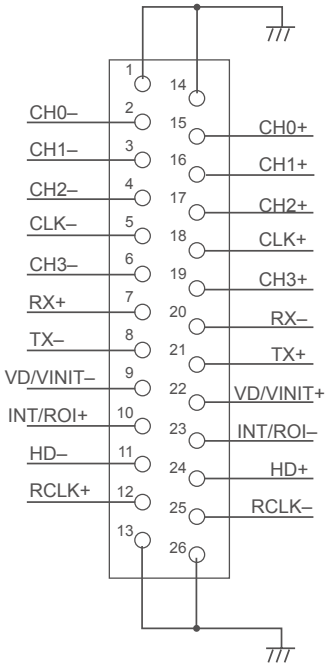




MDR 26-pin Connector 10226-6212VC

Pin#	Description	I/O
1	GND (shield)	
2	X0- (CH0-)	Out
3	X1- (CH1-)	Out
4	X2- (CH2-)	Out
5	Xclk- (CLK-)	Out
6	X3- (CH3-)	Out
7	SerTC+ (Rx+)	In
8	SerTFG- (Tx-)	Out
9	CC1- (Vinit/VD-)	In
10	CC2+ (Integ/ROI+)	In
11	CC3- (HD-)	In*
12	CC4+ (RCLK+)	In**
13	GND	
14	GND (shield)	
15	X0+ (CH0+)	Out
16	X1+ (CH1+)	Out
17	X2+ (CH2+)	Out
18	Xclk+ (CLK+)	Out
19	X3+ (CH3+)	Out
20	SerTC- (Rx-)	In (LVDS or RS-232)
21	SerTFG+ (Tx+)	Out
22	CC1+ (Vinit/VD+)	In
23	CC2- (Integ/ROI-)	In
24	CC3+ (HD+)	In*
25	CC4- (RCLK-)	In**
26	Inner shield	

The 26-pin Connector Pin Assignment
(Camera Side)



Node description:
CH0: Data B0, A5, A4, A3, A2, A1, A0
CH1: Data C1, C0, B5, B4, B3, B2, B1
CH2: Data DVAL, FVAL, LVAL, C5, C4, C3, C2
CH3: Data SPARE, C7, C6, B7, B6, A7, A6
CLK: Data clock
RX, TX: Serial communication, RX = Ser to Cam□
□ TX = Ser to FG
VD/VINIT: Ext. VD in or VINIT (Triger) in
INT/ROI: Integration control in or □
□ Read-Out-Inhibit in
HD: External HD in
RCLK: External read clock in

* *HD, VD for external sync input. (Please contact PULNiX for Ext. HD input)*
** *RCLK is reserved for read clock input.*

Camera Link Signal Assignment to Channel Link Chip (RGB 8-bit x 3)

Tx IN0	Data R0 (LSB)	Tx IN8	G1	Tx IN16	B6	Tx IN24	LDV
Tx IN1	Data R1	Tx IN9	G2	Tx IN17	B7	Tx IN25	FDV
Tx IN2	Data R2	Tx IN10	G6	Tx IN18	B1	Tx IN26	LPULSE
Tx IN3	Data R3	Tx IN11	G7	Tx IN19	B2	Tx IN27	R6
Tx IN4	Data R4	Tx IN12	G3	Tx IN20	B3	Tx CLK	Data clock
Tx IN5	Data R7 (MSB)	Tx IN13	G4	Tx IN21	B4		
Tx IN6	Data R5	Tx IN14	G5	Tx IN22	B5		
Tx IN7	Data G0	Tx IN15	B0	Tx IN23	(YCC CLK)		

Note1: CLK: data clock, LDV: Line data valid, FDV: Frame data valid, INTEG: Integration control, VINIT: Async Trigger Input, ROI: Read-out-inhibit.
Note2: Data R_{0-7} is defined as A_{0-7}, Data G_{0-7} is defined as B_{0-7}. Data B_{0-7} is defined as C_{0-7}. For 8-bit B/W, only A_{0-7} is used. For 8-bit x 2 A_{0-7} and B_{0-7} are used.
Note3: Camera control via 12-pin connector (RS-232) is available as an option.

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Camera Link Camera Models

Camera models B/W Cameras	CCD (In)	Resolution	Frame rate (frame/sec.)	Data Clock (MHz)	Data	Analog video	Size (HxWxL mm)
TM-6760CL	1/2	648 x 484	60/30	25.49/12.75	Ch-A 8-bit	BNC: VGA video	44 x 44 x 64
TM-6710CL	1/2	648 x 484	120/60	25.49/12.75	Ch-A & B 8-bit x 2	BNC: 120 fps @ 50MHz	39 x 46 x 140
TM-1400CL	1/2	1392 x 1040	20	33.3	Ch-A 8-bit	BNC: progressive scan	44 x 44 x 64
TM-1320A-15CL	2/3	1300 x 1030	15	25.0	Ch-A 8-bit	BNC: progressive scan	44 x 44 x 64
TM-1320A-24CL	2/3	1300 x 1030	24	40.0	Ch-A 8-bit	BNC: progressive scan	44 x 44 x 64
TM-1325CL	2/3	1392 x 1040	15/30	33.3	Ch-A 8-bit	BNC: progressive scan	44 x 44 x 64
TM-1020-15CL	1	1008 x 1018	15	20.0	Ch-A 8-bit	BNC: progressive scan	44 x 44 x 64
TM-2016-8CL	1	1920 x 1080	8	20.0	Ch-A 8-bit	BNC: progressive scan	44 x 44 x 64
TM-2016-15CL	1	1920 x 1080	15	40.0	Ch-A 8-bit	BNC: progressive scan	44 x 44 x 64
TM-4000CL	1.2	2048 x 2048	15	40.0	8-bit x 2	BNC: progressive scan	51 x 51 x 82
Color Cameras							
TMC-6700CL	1/2	648 x 484	60	25.49	Ch-R,G,B 8-bit x 3	Dsub: RGB video VGA video	51 x 67 x 117
TMC-1000CL	1	1008 x 1018	15	20.0	Ch-R,G,B 8-bit x 3	Dsub: RGB video progressive scan	51 x 67 x 117
TMC-6760CL$^{\Delta}$	1/2	648 x 484	60	25.49/12.75	Ch-A 8-bit	BNC: VGA video	44 x 44 x 64
TMC-6710CL	1/2	648 x 484	120	25.49	Ch-A & B 8-bit x 2	BNC: 120 fps @ 50MHz VGA video	39 x 46 x 140
TMC-1400CL$^{\Delta}$	1/2	1392 x 1040	20	33.3	Ch-A 8-bit	BNC: progressive scan	44 x 44 x 64
TMC-1320A-15CL$^{\Delta}$	2/3	1300 x 1030	15	25.0	Ch-A 8-bit	BNC: progressive scan	44 x 44 x 64
TMC-1320A-24CL$^{\Delta}$	2/3	1300 x 1030	24	40.0	Ch-A 8-bit	BNC: progressive scan	44 x 44 x 64
TMC-1325CL	2/3	1392 x 1040	15/30	33.3	Ch-A 8-bit	BNC: progressive scan	44 x 44 x 64
TMC-1020-15CL$^{\Delta}$	1	1008 x 1018	15	20.0	Ch-A 8-bit	BNC: progressive scan	44 x 44 x 64
TMC-2016-8CL$^{\Delta}$	1	1920 x 1080	8	20.0	Ch-A 8-bit	BNC: progressive scan	44 x 44 x 64
TMC-4000CL$^{\Delta}$	1.2	2048 x 2048	15	40.0	Ch-A & B 8-bit x 2	BNC: progressive scan	51 x 51 x 82

$^{\Delta}$ AccuPiXEL color cameras require software interpolation.

Please contact PULNiX for availability. For detailed camera specifications, please refer to the standard camera data sheet for each model.

For product updates and data sheets, see our web site:

www.jaipulnix.com

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71-0048 Rev B.10.21.2003

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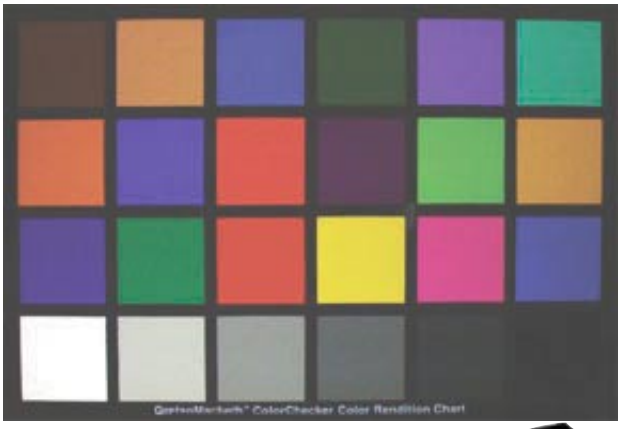
PULNiX Color AccuPiXEL™

New Product Summary

- High-resolution, high-speed progressive scan interline transfer CCD imagers
- Digital Camera Link, RS-644 (LVDS) output and analog output
- Bayer color filter arrays
- Maximum dynamic range control with built-in look-up table (Gamma, knee, user parameters)
- Full-frame integration, partial scan, two-row binning
- Smaller, lightweight housing with high-rel connector
- Full-frame shutter up to 1/16,000 sec.
- Asynchronous reset, no-delay shutter, read-out-inhibit control
- RS-232 or Camera Link external control
- Excellent color reproduction with various color interpolation software



Actual image taken with the TMC-1320

General Description

The PULNiX AccuPiXEL series color cameras are high-resolution, high-speed progressive scan CCD cameras. The interline transfer, progressive scan CCD permits full vertical and horizontal resolution of images acquired at very high shutter speeds. The electronic shutter, which has speeds to 1/16,000 sec., can be reset asynchronously by external pulse control. Uniform square pixels provide superior image definition in any orientation. On-chip micro lenses mean increased sensitivity.

Color Filter Array

PULNiX AccuPiXEL cameras use Bayer CFA (color filter array) as their standard primary color filter. This filter provides the most popular color interpolation supported by numerous software suppliers.

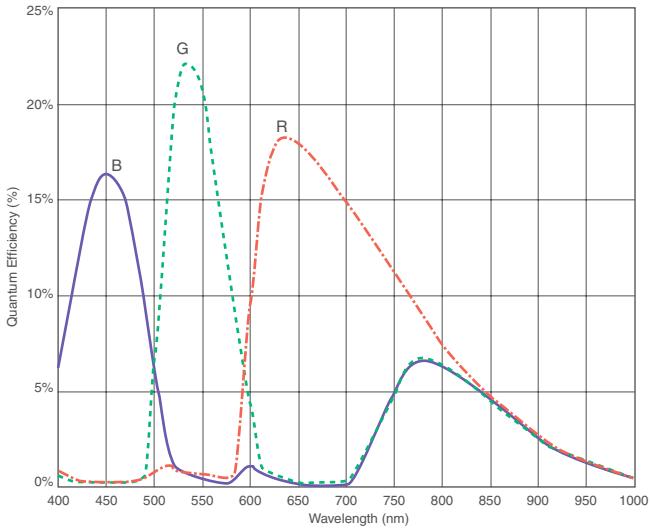
The digital format, either Camera Link or RS-644, allows the camera to output accurate pixel data, including the color information. When the data is stored in the frame buffer of a frame grabber or computer, the color information is easily manipulated to restore the original color images. Because the color filter array contains only a single R, G or B color in each pixel, the restored image has to fill in colors in the missing pixel locations. The software uses neighboring pixel information to “guess” the missing colors to make smooth, clear images. This is called “Color Interpolation.” Today’s high-speed computers allow such color interpolation to be done almost in real time. Because these cameras do not contain internal color-processing circuitry, they are smaller and less expensive than full-function color cameras.

Bayer Color Filter Array (CFA)

The Bayer CFA is an R, G, B primary color filter array. This is the most widely accepted CFA for the single-chip CCD progressive scan format. This type of array layout has a specific order for each color’s pixels. Since the human eye’s resolution and color recognition are highest at green, the CFA contains two greens per each red and blue.

It is critical for the frame grabber and color interpolation to know where the individual color pixels exist relative to sync (LDV and FDV) timing.

This requirement makes digital output the preferred choice, because the timing relationships are very accurate.



Starting Pixel Configuration

All manufacturers produce identical Bayer CFAs, but there are slight differences between the CCDs produced by different manufacturers. The first line is generally R and G, except for the Kodak CCD, which starts with G. The Sony CCD starts with R. The camera timing can be adjusted to start with either G or R by skipping the very first pixels at each lines. The majority of color interpolation software can select between a variety of pixel relations, such as R/G start or G/R start, as well as G/B start and B/G start. Once the correct scanning is configured, the rest of the interpolation will be exactly the same.

Please contact JAI PULNiX for further information regarding CCD manufacturers.

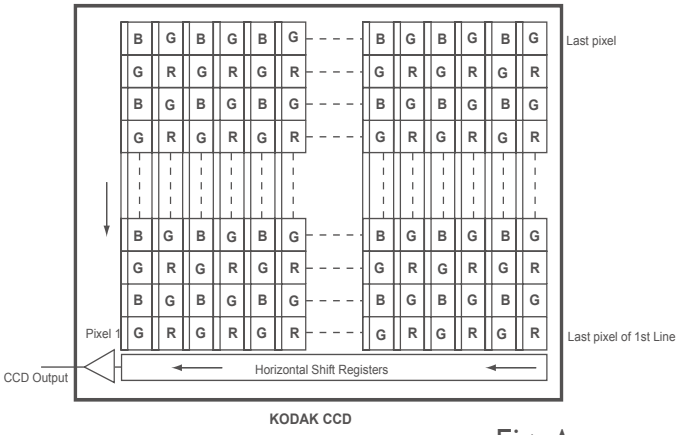


Fig. A

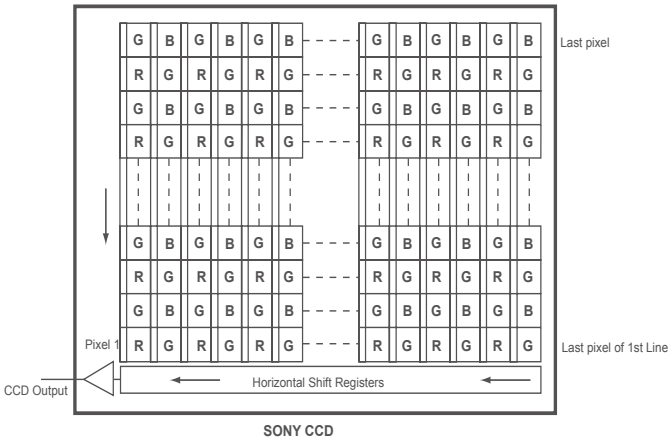


Fig. B

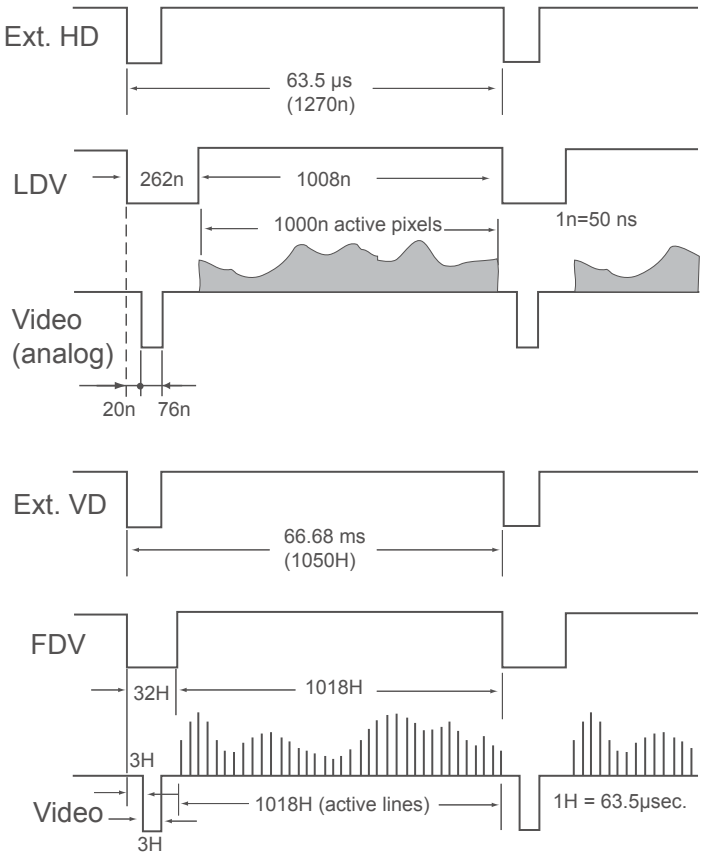
Sync and Data

The individual color data is exactly the same as the pixel data. This means that the timing relationships of the color cameras are also the same as of the B/W cameras.

For a detailed timing chart, please refer to each B/W camera's data sheet and manual.

If the frame grabber has a standard B/W configuration file, then AccuPiXEL color cameras can use that configuration file to operate. The configuration file may vary, depending on whether the output is standard (RS-644) or Camera Link. Please consult JAI PULNiX, or your frame grabber supplier for compatibility information.

The following diagram is an example of the TMC-1020-15 (same as TM-1020-15).



It is important to meet the exact starting pixel at LDV and the starting line of FDV. If the starting pixel or line is shifted due to the image capture configuration, then the interpolation software can be adjusted for the correct starting point. In figure A, if the first pixel is shifted (missed), the color interpolation should start with R-G. If the first line is missed in A, the interpolation order will be B-G.

Camera Functions

AccuPiXEL color cameras perform all functions the same way as B/W cameras. However, because of color characteristics, the following issues are different:

1. Two-row binning scan

When two rows are mixed in the CCD, the Bayer color is no longer valid. It provides color information but cannot be interpolated as a Bayer CFA.

2. LUT (Look-up Table)

LUT is a powerful tool to adjust the dynamic range as well as color dynamic range. Since human color perception is non-linear, LUT selection can help optimize color contrast by selecting the LUT value. Gamma 0.45 is logarithmic and is closed to human perception.

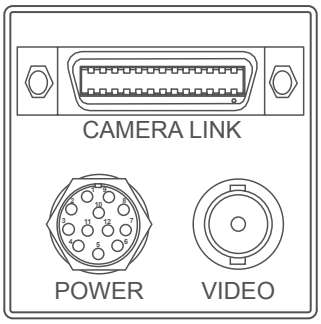
When LUT is selected, black-level adjustment must be more accurate than for B/W cameras.

For a detailed timing chart, please refer to the standard AccuPiXEL camera data sheet, or contact JAI PULNiX.

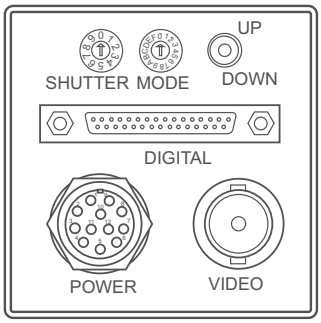
Basic Mode Selections (For Non-CL Versions)*

	Mode Switch	Up/Down Switch	Functions
0	Switch Disabled	Switch Disabled	None
1	Set Gain	Up / Down	Change gain
2	Set Vtop (A/D)	Up / Down	Change A/D ref. top
3	Set Vbottom (A/D)	Up / Down	Change A/D ref bottom
4	Gain Selection #1	Up: 9dB, Down: 12dB	Lower gain selection
5	Gain Selection #2	Up: 18dB, Down: 22dB	Higher gain selection
6	Linear LUT	Up	Back to linear table
7	Knee Selection	Up / Down (Scroll)	Scroll 10 different LUTs
8	Async Reset Mode	Up: Normal, Dwn: Async	Async and normal shutter
9	Factory Default Recall	Up / Down: Recall	Factory setting
A	Power up Setting	Up: Recall, Dwn: Save	Power up page setting
B	User Page Storage#1	Up: Recall, Dwn: Save	User page storage setting
C	User Page Storage#2	Up: Recall, Dwn: Save	User page storage setting
D	Direct Shutter Control	Up / Down	Shutter speed increment by 1H
E	Scan Format2	Up: Optional, Dwn: Binning	Two-row binning selection
F	Scan Format1	Up: Normal, Dwn: Optional	Custom option scanning

**These mode descriptions may change from camera model to camera model slightly. The same functions are controlled by RS-232 or Camera Link software.*



Camera Link model rear panel



LVDS model rear panel.
Does not apply to TMC-4000

Interpolation Software

Major frame grabber manufacturers with digital capability (Camera Link, RS-644) provide color interpolation software. Some independent image process software suppliers provide software as well.

The following table lists a few examples.

Manufacturer	Frame Grabber	Software
Matrox	Meteor II Digi, CL	MIL
Bitflow	Road Runner CL	Bay View
Coreco	T64	Application software
Data Cube	MaxRevolution	Visual Chip Studio
Epix	PIXCI	Application software
Euresys	GrabLink	Easygrab EasyColor
Matrix Vision	MV-Titan/CL	Impact
Silicon Software	microEnable III	microDisplay

Color Interpolation

The Bayer pattern color filter array (CFA) consists of R, G, and B primary colors. Each pixel represents one of three colors. In order to display or print color images, the signal has to be converted to RGB output, which has three independent channels (outputs) and sync signals.

Color interpolation software or firmware performs the color preprocessing by filling the missing color pixels with neighboring pixels. It then separates the stream of data, (8-bit or 10-bit) into 3 (RGB) data (8-bit x 3) and adds the color matrix to adjust and balance each of the R,G, and B channels (white balance or color balance).

Green	Red	Green
Blue	Green	Blue
Green	Red	Green

The image quality depends on the camera's own pixel data (including pixel data independency from neighboring pixels, noise and color filter), and interpolation of the software algorithm such as 3 x 3 interpolation, 2 x 2 interpolation, color matrix, white balance capability, etc.

All AccuPiXEL color cameras are carefully designed for maximum color performance. JAI PULNiX strongly suggests that you use digital output for the best performance.

Some software is used on board (FPGA or DSP) to perform the interpolation. Other software simply uses the host computer's memory and CPU. The process speed may vary depending on the architecture and speed of the computer.

Color AccuPiXEL Cameras

Camera models AccuPiXEL Color	CCD	Resolution	Frame Rate (frame/sec)	Data Clock (NHz)	Data	Analog Video	Size (HxWxL in mm)
TMC-6760	1/2”	648 x 484	60	25.0/12.50	8-bit	BNC: VGA video	44 x 44 x 64
TMC-6760CL	1/2”	648 x 484	60	25.0/12.50	Ch-A 8-bit	BNC: VGA video	44 x 44 x 64
TMC-1400	1/2”	1392 x 1040	15/30	33.3	8-bit	BNC: progressive scan	44 x 44 x 64
TMC-1400CL	1/2”	1392 x 1040	15/30	33.3	Ch-A 8-bit	BNC: progressive scan	44 x 44 x 64
TMC-1320A-15	2/3”	1300 x 1030	15	25.0	8-bit	BNC: progressive scan	44 x 44 x 64
TMC-1320A-15CL	2/3”	1300 x 1030	15	25.0	Ch-A 8-bit	BNC: progressive scan	44 x 44 x 64
TMC-1320A-24	2/3”	1300 x 1030	24	40.0	8-bit	BNC: progressive scan	44 x 44 x 64
TMC-1320A-24CL	2/3”	1300 x 1030	24	40.0	Ch-A 8-bit	BNC: progressive scan	44 x 44 x 64
TMC-1325	2/3”	1392 x 1040	15/30	33.3	8-bit	BNC: progressive scan	44 x 44 x 64
TMC-1325CL	2/3”	1392 x 1040	15/30	33.3	Ch-A 8-bit	BNC: progressive scan	44 x 44 x 64
TMC-1020A-15	1”	1008 x 1018	15	20.0	8-bit	BNC: progressive scan	44 x 44 x 64
TMC-1020A-15CL	1”	1008 x 1018	15	20.0	Ch-A 8-bit	BNC: progressive scan	44 x 44 x 64
TMC-2016-8	1”	1920 x 1080	8	20.0	8-bit	BNC: progressive scan	44 x 44 x 64
TMC-2016-8CL	1”	1920 x 1080	8	20.0	Ch-A 8-bit	BNC: progressive scan	44 x 44 x 64
TMC-4000CL	1.2”	2048 x 2048	15	40.0	Ch-A & B 8-bit x 2	BNC: progressive scan	*51 x 51 x 82*

CL: Camera Link

Please contact PULNiX for availability. For detailed camera specifications, please refer to the standard camera data sheet for each model.

For product updates and data sheets see our web site:

www.jaipulnix.com

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71-0069 Rev B.10.10.2003

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